

LIET 151 2nd Exam	2010. 5. 15	Dept:	ID#:	Name:
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1. Arrange the following atoms in order of increasing first ionization energy (smallest first): Ar, Cl, Cs, K

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2. Arrange the following atoms in order of increasing size (smallest first): Cl, F, P, S

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3. List the ionic species that are isoelectronic with Ar and have net charge (absolute values) with $Z \leq 20$. Arrange these in order of increasing size (smallest first).

4. Light with a wavelength of 2.50×10^{-7} m falls on the surface of a piece of chromium in an evacuated glass tube. If the binding energy of electrons to the metal surface is 7.21×10^{-19} J, determine

(a) the maximum kinetic energy (J) of the emitted electrons

(b) the speed (m s^{-1}) of electrons that have this maximum kinetic energy.

5. Suppose an atom in an excited state can return to the ground state in two steps. It first falls to an intermediate state, emitting radiation of wavelength λ_1 , and then to the ground state, emitting radiation of wavelength λ_2 . The same atom can also return to the ground state in one step, with the emission of radiation of wavelength λ_3 .

(a) How are λ_1 , λ_2 , and λ_3 related?

(b) How are the frequencies of the three radiations (ν_1 , ν_2 , and ν_3 for λ_1 , λ_2 , and λ_3 , respectively)

6.

(a) A piston performs work of 210 L atm on the surroundings, while the cylinder in which it is placed expands from 10 L to 25 L. At the same time, 45 J of heat is transferred from the surroundings to the system. Against what pressure was the piston working?

(b) A sample of an ideal gas at 15.0 atm and 10.0 L is allowed to expand against a constant external pressure of 2.00 atm at a constant temperature. Calculate the work (kJ) for the gas expansion.

7. A hot-air-balloon is filled with air to a volume of $4.00 \times 10^3 \text{ m}^3$ at 745 torr and 21°C . The air in the balloon is then heated to 62°C , causing the balloon to expand to a volume of $4.20 \times 10^3 \text{ m}^3$. What is the ratio of the number of moles of air in the heated balloon to the original number of moles of air in the balloon? (Hint: Opening in the balloon allow air to flow in and out. Thus the pressure in the balloon is always the same as that of the atmosphere).

8. Consider a sample of a hydrocarbon (a compound consisting of only carbon and hydrogen) at 0.959 atm and 298 K. Upon combusting the entire sample in oxygen, you collect a mixture of gaseous carbon dioxide and water vapor at 1.51 atm and 375 K. The mixture has a density of 1.391 g/L and occupies a volume four times as large as $\frac{1}{4}$ of the pure hydrocarbon. Determine the molecular formula of the hydrocarbon.

9. A ballon filled with 39.1 mol helium has a volume of 876 L at 0.0 °C and 1.00 atm. The temperature of the ballon is increased to 38.0 °C as it expands to a volume of 998 L, the pressure remaining constant. Calculate q, w, ΔE for the helium in the ballon. The molar heat capacity for helium gas is 20.8 J/°C·mol.

(a) q (kJ)

(b) w (kJ)

(c) ΔE (kJ)

10. In a coffee-cup calorimeter, 100.0 mL of 1.0 M NaOH and 100 mL of 1.0M HCl are mixed. Both solutions were originally at 24.6 °C. After the reaction, the final temperature is 31.3 °C. Assuming that all the solutions have a density of 1.0g/cm³ and a specific heat capacity of 4.18 J/°C·g, calculate the enthalpy change (ΔH, kJ/mol) for the neutralization of HCl by NaOH. Assume that no heat is lost to the surrounding or to the calorimeter.

11. Does more heat have to be removed from an automobile engine when it burns one gram of gasoline while idling in a traffic jam or when it burns one gram of gasoline while accelerating? Explain in terms of ΔE, q, and w.

12. The following are hypothetical configurations for a beryllium atom.

- (1) 1s³ 2s¹ (2) 1s¹ 2s³ (3) 1s¹ 2p³
 (4) 1s² 2s¹ 2p¹ (5) 1s² 2s² (6) 1s² 1p²

(a) Which are forbidden by the Pauli principle?

(b) Which are excited states?

(c) Which are the ground-state

13. Write the complete electron configuration, and list a correct set of values of the quantum numbers for each of valence electrons in the ground-state configuration of F and Mg.

(a) F

n *l* *m_l* *m_s*

(b) Mg

n *l* *m_l* *m_s*

14. Show the ground-state electron configuration of two transition metal cations: ²⁹Cu²⁺ and ²⁴Cr³⁺.

(a) Cu²⁺ [Ar] 4s  3d 

(b) Cr³⁺ [Ar] 4s  3d 

15. Choose all correct sentences. ()

- (a) In a hydrogen atom, the 2s and 2p orbitals have identical energy.
 (b) In a helium atoms, the 2s and 2p orbitals have different energy.
 (c) All three 2p orbitals of a helium atom have identical energy.
 (d) The ionization energy (IE) of the He 1s¹ 2p¹ excited state is nearly the same as the IE of the H 2p¹ excited state.

$$R = 8.3145 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$R = 8.2057 \text{ L atm mol}^{-1} \text{ K}^{-1}$$

$$h = 6.626 \times 10^{-34} \text{ J s}$$

$$c = 3.00 \times 10^8 \text{ m s}^{-1}$$